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(54) COMPOSITE MAGNETIC TAPE

(57) A composite magnetic tape which can be readily applied to electronic equipment regardless on the inside and outside of the equipment and can prevent the radiation and reflection of unnecessary electromagnetic waves from and to the inside of the equipment and, at the same time, can intercept electromagnetic noise from the outside. The tape can be formed in the form of an adhesive tape or autoadhesive tape. The tape is constituted of a composite magnetic layer formed by scattering soft magnetic power in an organic binder or in a laminated constitution of the composite magnetic layer and a conductive layer.

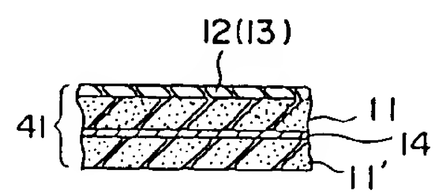

Fig. 4

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Description

Technical Field

The present invention relates to means for electromagnetic shielding and electromagnetic noise suppression in the electric and electronic industries and, in particular, to a tape to be used therefor.

Background Art

Conventionally, in the electric and electronic industries, tapes using Cu, Al or stainless sheets have been known for magnetic shielding or electric connection. Such a tape has a width of about 10 to 20mm and a thickness of about 0.1 to 0.3mm, and is wound in a belt fashion. Adhesive tapes obtained by applying an adhesive to the foregoing Cu, Al or stainless tapes have also been known. Further, as self-welding tapes, those obtained by applying a self-welding agent, such as polyester or polyamide, to the foregoing Cu, Al or stainless tapes have been known.

There is a possibility that electronic equipments may malfunction due to undesired electromagnetic waves (electromagnetic noise) from the exterior. As such electromagnetic noise, there are electromagnetic waves caused by other communications, undesired electromagnetic waves radiated from various kinds of equipments and devices used therein, and electromagnetic waves due to reflection. Therefore, shielding is essential in electronic equipments and various kinds of equipments radiating undesired electromagnetic waves for preventing radiation of the electromagnetic waves and invasion of the electromagnetic waves from the exterior.

In view of this, conductor plates (shield plates) have been used in these equipments. If the shield plates are used, the number of parts of the equipment is increased to cause high cost.

Accordingly, for realizing a shield effect easily and cheaply, it is considered to use the foregoing tapes.

However, the foregoing conventional tape is small in magnetic shield effect relative to high frequency waves of portable telephones, PHS's, transceivers, electronic equipments or the like, particularly, electromagnetic waves at several hundred to thousand MHz bands. Therefore, there has been necessity for such tapes as having the magnetic shield effect over the wide frequency band, instead of the conventional tapes.

Further, if the foregoing tape or shield plate is used carelessly, there is raised a problem that the tape or shield plate may function as an antenna or secondary radiant noise due to reflection may be generated, so as to cause an influence to other devices in the same equipment.

An object of the present invention is to provide an electromagnetic interference suppressing tape which can protect an equipment from undesired electromagnetic waves from the exterior and prevent even radiant noise and/or reflection noise in the same equipment, and further can be easily used.

Disclosure of the Invention

The present invention, as recited in claim 1, provides a composite magnetic tape characterized by comprising a thin film of a composite magnetic body formed by dispersing soft magnetic powder into an organic binding agent.

Further, the present invention, as recited in claim 2, provides a composite magnetic tape characterized by comprising a thin film of a multilayered structure in which a composite magnetic layer formed by dispersing soft magnetic powder into an organic binding agent and a conductor layer are stacked.

Modifications by the present invention and typical examples of carrying-out manners are recited in dependent claims.

Brief Description of the Drawings

Fig. 1 is a perspective view of a composite magnetic tape according to the present invention.

Fig. 2 is a perspective view of a composite magnetic tape provided with an adhesive layer according to the present invention.

Fig. 3 is a perspective view of a composite magnetic tape provided with a self-welding layer according to the present invention.

Fig. 4 is a sectional view of a composite magnetic tape constituted of two composite magnetic layers and a metal layer and provided with an adhesive layer.

Fig. 5 is a μ-f characteristic diagram of a composite magnetic body used in a composite magnetic tape of the present invention.

Fig. 6 is a graph showing transmittance attenuation levels of samples according to the present invention and a comparative sample.

Fig. 7 is a graph showing electromagnetic coupling levels of the same samples.

Fig. 8 is an explanatory diagram showing a measuring method of the transmittance attenuation level.

Fig. 9 is an explanatory diagram showing a measuring method of the coupling level.

Best Mode for Carrying Out the Invention

Hereinbelow, embodiments of the present invention will be described with reference to the drawings.

Referring to Fig. 1, the shown embodiment shows a roll 1 formed by winding a tape 11 composed of only a thin film of a composite magnetic body formed by dispersing soft magnetic powder into an organic binding agent.

As shown by 11, 11' in Fig. 4, a section of the tape 11 has a structure in which the soft magnetic powder (shown by dots) is dispersed into a layer of the organic binding agent (shown by hatching of oblique thick lines).

As the foregoing soft magnetic powder, an Fe-Al-Si alloy or an Fe-Ni alloy having a large high frequency permeability can be cited.

As the foregoing organic binding agent, thermoplastic resin, such as polyester resin, polyvinyl chloride resin, polyvinyl butyral resin, polyurethane resin, cellulose resin, nitrile-butadiene rubber or stylene-butadiene rubber, or a polymer thereof can be cited. Further, chlorinated polyethylene can also be used. Particularly, an elastomer having elasticity is suitable for tape.

Referring to Fig. 2, the shown embodiment shows a roll 2 formed by winding an adhesive tape 21 which is obtained by applying a thin layer 12 (in the figure, shown by hatching of horizontal lines) of an adhesive onto the surface of a tape 11 constituted of a thin film of a composite magnetic body formed by dispersing soft magnetic powder into an organic binding agent.

Referring to Fig. 3, the shown embodiment shows a roll 3 formed by winding a self-welding tape 31 which is obtained by applying a thin layer 13 (in the figure, shown by hatching of mesh) of a self-welding agent onto the surface of a tape 11 constituted of a thin film of a composite magnetic body formed by dispersing soft magnetic powder into an organic binding agent.

Fig. 4 shows an example in which a thin film forming a tape has a stacked structure of layers of composite magnetic bodies and a metal layer. The shown example is an adhesive tape 41 of a structure, wherein a metal layer 14 is interposed between tape layers 11 and 11' composed of composite magnetic bodies, and an adhesive layer 12 is provided on the surface of the tape layer 11 composed of the composite magnetic body.

As the metal layer, a metal foil, a net made of metal wires (metal mesh), an electroless plating layer, a deposited metal layer or the like may be used.

On the other hand, a self-welding agent layer 13 may be used instead of the adhesive layer 12 so as to form a self-welding tape. For showing this, (13) is added adjacent to reference sign 12 in the figure. Naturally, if not necessary, the adhesive layer 12 and the self-welding agent layer 13 both can be omitted.

One composite magnetic layer is acceptable. On the other hand, a plurality of composite magnetic layers and metal layers may be stacked.

Table 1 shows an example of the composite magnetic body used in the embodiments shown in Figs. 1 to 4.

Table 1

Soft magnetic powder	
Fe-Al-Si alloy Average particle diameter: 45 μm Aspect ratio: >5 Annealing: Ar atmosphere 650°C, 2 hours	80 weight parts
Organic binding agent (chlorinated polyethylene)	20 weight parts

The composite magnetic body was produced in the following manner. The soft magnetic powder obtained by a normal method was vapor-phase oxidized in an atmosphere of nitrogen-oxygen mixed gas at a 20% oxygen partial pressure, and oxide films were formed on the surfaces thereof. The powder and chlorinated polyethylene were heated and kneaded, and then formed under pressure to obtain a formed body of the composite magnetic body. The surface resistance of the composite magnetic body was measured and found to be $1 \times 10^6 \Omega$.

Fig. 5 shows a measured μ-f (permeability-frequency) characteristic of the foregoing composite magnetic body. Solid lines represent μ characteristics after annealing, while broken lines represent μ characteristics before annealing. As shown in Fig. 2, the composite magnetic body before annealing has peaks in μ" (complex permeability) which appear following the magnetic resonance, and it is observed that the magnetic resonance occurs at two points. After it

is subjected to the annealing, it is seen that μ" reveals high values over a wide range, and μ" also reveals large values at high frequencies.

Hereinbelow, examples of composite magnetic tapes according to the present invention will be described.

Example 1

Using the composite magnetic body shown in Table 1, as shown in Fig. 1, a tape 11 having a mean width of 15mm and a mean thickness of 0.3mm was formed.

Example 2

As shown in Fig. 4, the composite magnetic body of Table 1 was formed into two layers 11 and 11' and a nickel mesh was interposed therebetween as a conductor layer 7, to form a multilayered structure so that a tape composed of a thin belt 2 having a mean dimension of 15mm and a mean thickness of 0.3mm was formed. The nickel mesh of 100 meshes with t = 0.05mm was used. In this example, neither the adhesive layer 12 nor the self-welding layer (13) was used.

Example 3

Using the composite magnetic body of Table 1, a tape 11 having a mean width of 15mm and a mean thickness of 0.3mm was formed. Then, as shown in Fig. 2, an adhesive 12 having electrically insulating and conductive properties was applied to the tape 11 to obtain an adhesive tape 21.

Example 4

As shown in Fig. 4, the composite magnetic body of Table 1 was formed into two layers 11 and 11' and a nickel mesh was interposed therebetween as a conductor layer 7, to form a multilayered structure so that a tape composed of a thin belt having a mean width of 15mm and a mean thickness of 0.3mm was formed. An adhesive layer 12 was applied to the surface of the tape to obtain an adhesive tape 41. The nickel mesh of 100 meshes with t = 0.05mm was used.

Example 5

Using the composite magnetic body shown in Table 1, a tape 11 having a mean width of 15mm and a mean thickness of 0.3mm was formed. Then, as shown in Fig. 3, a self-welding layer 13 made of epoxy resin as a main component was applied to the tape 11 to obtain a self-welding tape 31. As the main component of the self-welding layer, polyamide resin, polyester resin or the like may be used other than the epoxy resin.

Example 6

As shown in Fig. 4, the composite magnetic body of Table 1 was formed into two layers 11 and 11' and a nickel mesh was interposed therebetween as a conductor layer 7, to form a multilayered structure so that a tape composed of a thin belt having a mean width of 15mm and a mean thickness of 0.3mm was formed. The foregoing self-welding agent 13 was applied to the tape to obtain a self-welding tape 41. The nickel mesh of 100 meshes with t = 0.05mm was used.

With respect to samples of the examples 1 to 6, transmittance attenuation levels and coupling levels were measured, respectively.

As shown in Figs. 8 and 9, an apparatus having an electromagnetic wave generator 21 and an electromagnetic field strength measuring device (reception element) 22, which were connected to an electromagnetic field transmitting micro-loop antenna 23 and an electromagnetic field receiving micro-loop antenna 24 each having a loop diameter of not greater than 2mm, was used in the measurement. A spectrum analyzer, not shown, was connected to the electromagnetic field strength measuring device 22, and the measurement was carried out using as a reference an electromagnetic field strength in the state where no sample was present.

In the measurement of the transmittance attenuation level, as shown in Fig. 8, a sample 20 was disposed between the electromagnetic field transmitting micro-loop antenna 23 and the electromagnetic field receiving micro-loop antenna 24.

In the measurement of the coupling level, as shown in Fig. 9, the sample 20 was disposed so that one side thereof confronts the electromagnetic field transmitting micro-loop antenna 23 and the electromagnetic field receiving micro-loop antenna 24.

The transmittance attenuation levels and the coupling levels measured by the foregoing method are shown in Figs.

6 and 7, respectively. In the figures, characteristics of the examples 1 to 6 are shown by ① to ⑥ and, as a comparative example, characteristics of a metal shield plate in the form of a copper plate with a thickness t = 0.035mm are shown by ⑤.

As seen from Figs. 6 and 7, in the examples 1 to 6 according to the present invention, the transmittance attenuation levels and the coupling levels are both reduced. On the contrary, in the comparative example, it is seen that although the transmittance attenuation level is much reduced, the coupling level is increased. From the foregoing results, it is seen that the composite magnetic tape according to the present invention can effectively remove the radiant noise without inducing the secondary radiant noise due to reflection.

Industrial Applicability

According to the present invention, it is possible to provide a tape which can prevent high frequency radiation and reflection noise easily, like an insulating tape for electric insulation, without inducing secondary radiation, using a tape, an adhesive tape or a self-welding tape constituted of a composite magnetic body which can keep an electromagnetic absorption effect even at a high frequency band.

Claims

1. A composite magnetic tape characterized by comprising a thin film of a composite magnetic body formed by dispersing soft magnetic powder into an organic binding agent.

2. A compcsite magnetic tape characterized by comprising a thin film of a multilayered structure in which a composite magnetic layer formed by dispersing soft magnetic powder into an organic binding agent and a conductor layer are stacked.

3. A composite magnetic tape as recited in any one of claims 1 and 2, characterized by using the composite magnetic body having at least two magnetic resonances induced by anisotropic magnetic fields of mutually different strengths.

4. A composite magnetic tape as recited in any one of claims 1 to 3, characterized in that a surface of the tape has an adhesive layer.

5. A composite magnetic tape as recited in any one of claims 1 to 3, characterized in that a surface of the tape has a layer of a self-welding agent.

6. A composite magnetic tape as recited in any one of claims 1 to 5, characterized in that said organic binding agent is an elastomer.

7. A composite magnetic tape as recited in any one of claims 1 to 6, characterized in that said soft magnetic powder is powder being flat.

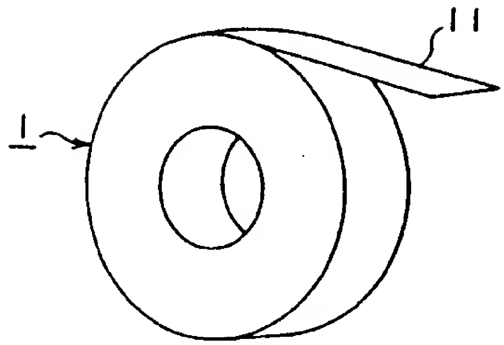

Fig. 1

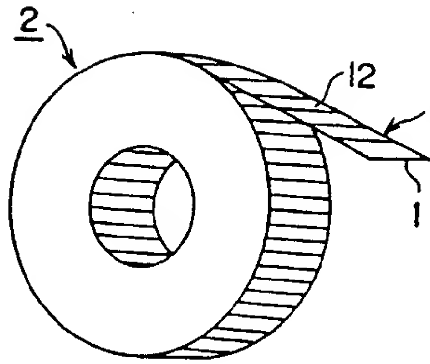

Fig.2

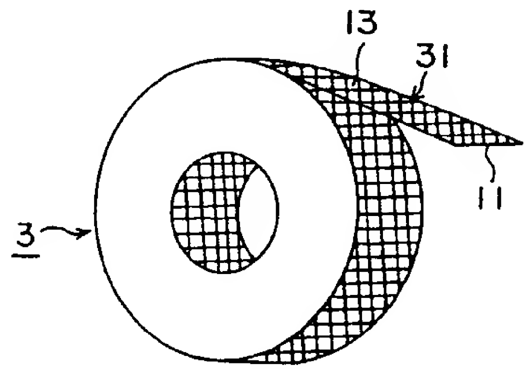

Fig. 3

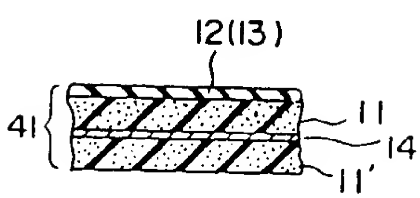

Fig. 4

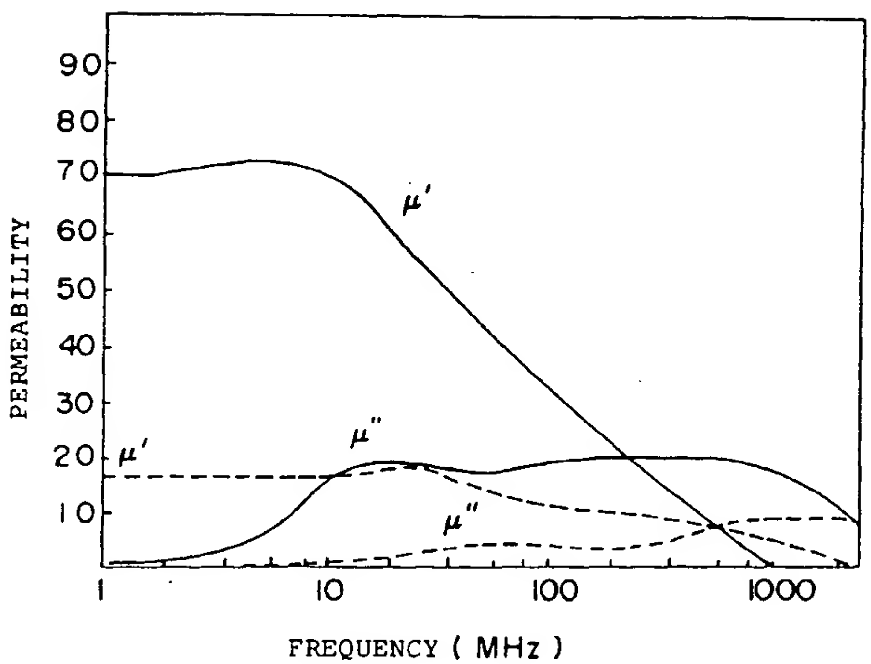
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Fig. 5

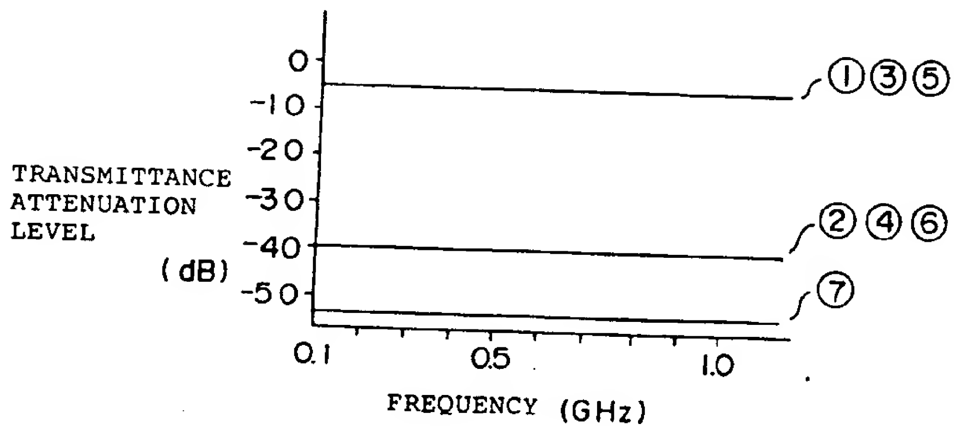

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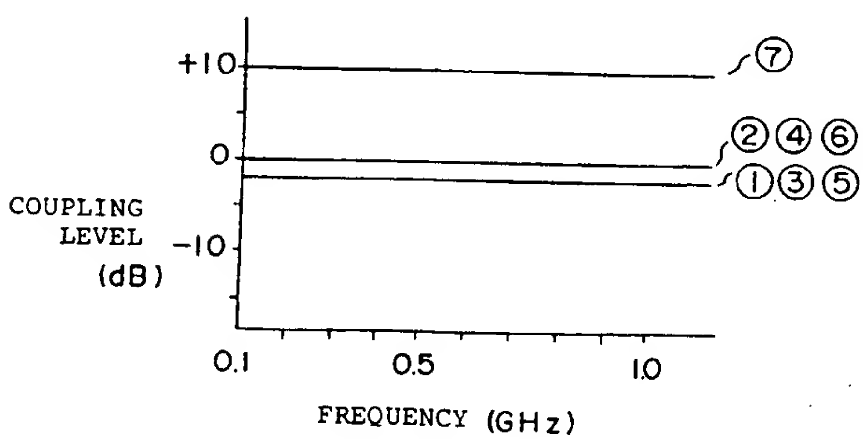
Fig. 6



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FREQUENCY (GHz)

Fig. 7

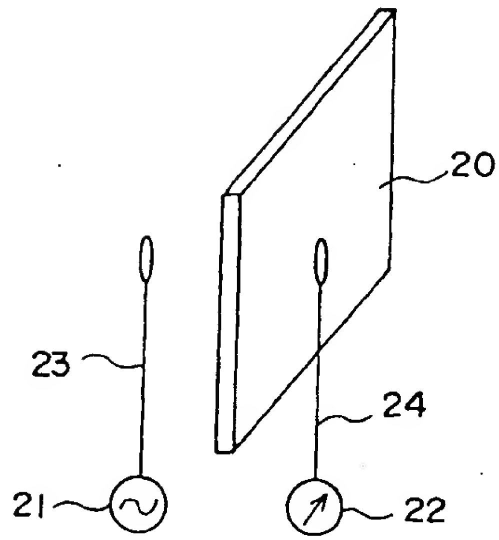

Fig. 8

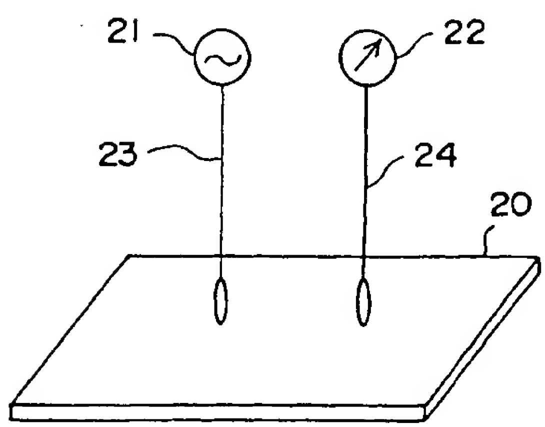

Fig. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP97/03045

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl[6] H01F1/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl[6] H01F1/24

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1926 - 1996	Jitsuyo Shinan Toroku Koho	1996 - 1997
Kokai Jitsuyo Shinan Koho	1971 - 1997		
Toroku Jitsuyo Shinan Koho	1994 - 1997		

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP, 2-178997, A (Riken Corp.), July 11, 1990 (11. 07. 90)(Family: none)	1, 2, 7 4, 5
X	JP, 2-180610, A (Riken Corp.), July 13, 1990 (13. 07. 90)(Family: none)	1, 2, 7
X	JP, 1-205404, A (TDK Corp.), August 17, 1989 (17. 08. 89) & EP, 301561, A & US, 4923533, A	1, 7
X	JP, 59-201493, A (TDK Corp.), November 15, 1984 (15. 11. 84)(Family: none)	1, 7
X	JP, 6-252586, A (Mitsubishi Materials Corp.), September 9, 1994 (09. 09. 94)(Family: none)	1, 7
Y	JP, 2-153003, A (Kobe Steel, Ltd.), June 12, 1990 (12. 06. 90)(Family: none)	1, 7
Y	JP, 5-299232, A (Matsushita Electric Industrial Co., Ltd.),	1, 3

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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Date of the actual completion of the international search October 28, 1997 (28. 10. 97)	Date of mailing of the international search report November 11, 1997 (11. 11. 97)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer - Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP97/03045

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	November 12, 1993 (12. 11. 93) (Family: none)	

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

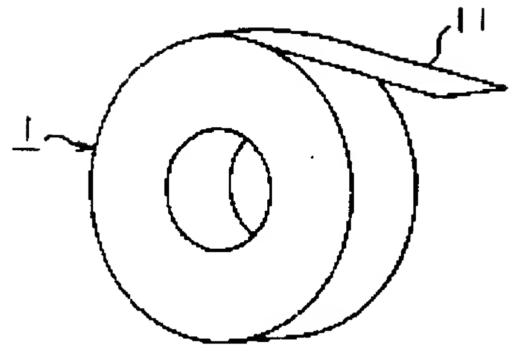


Fig. 1

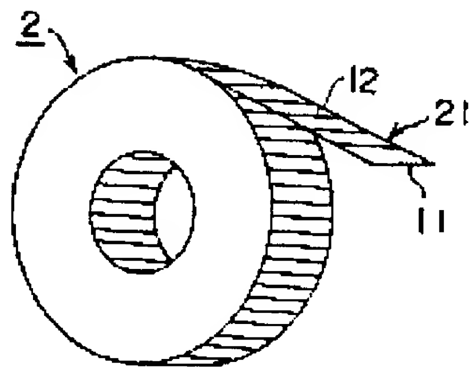


Fig.2

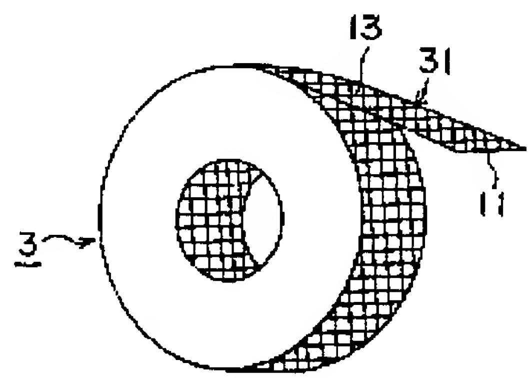


Fig. 3

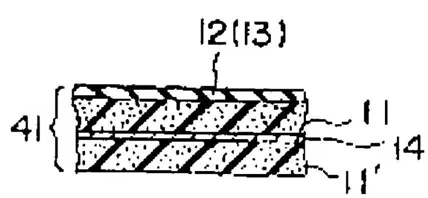
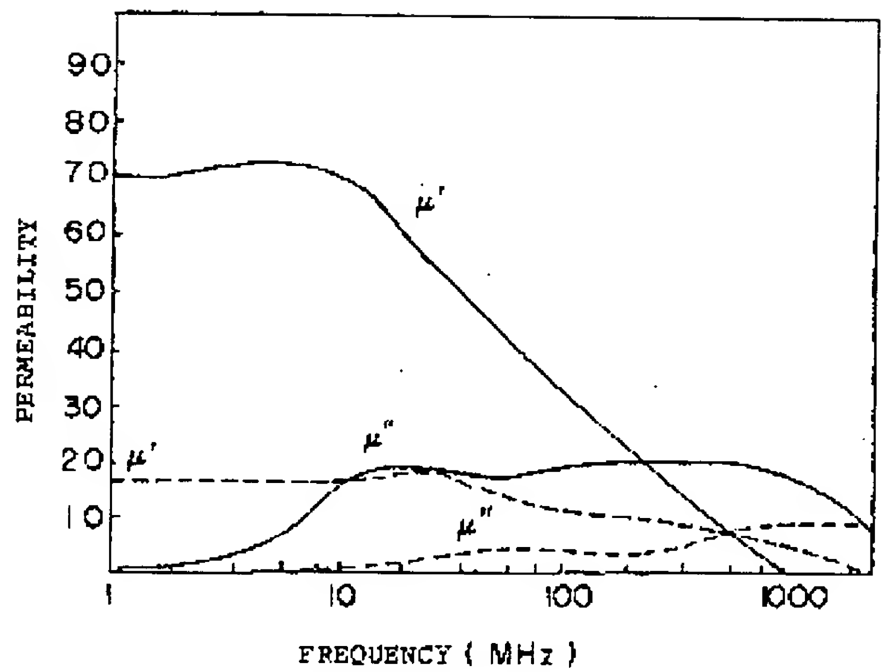


Fig. 4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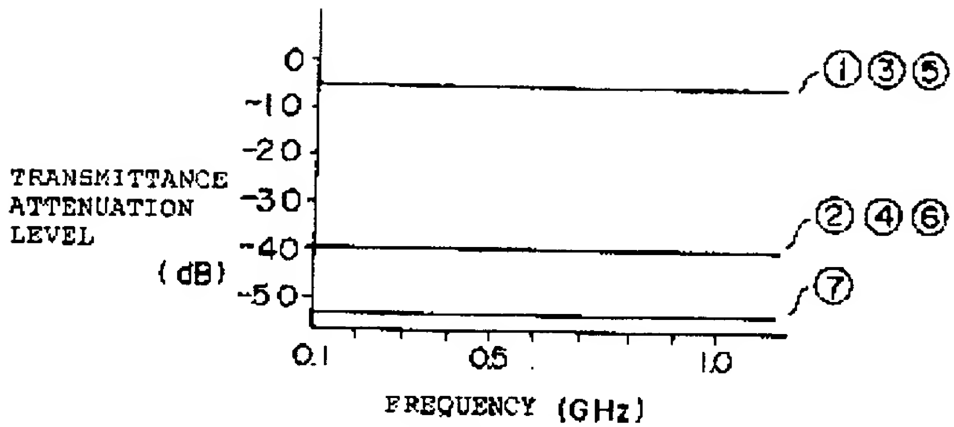
FREQUENCY (MHz)

Fig. 5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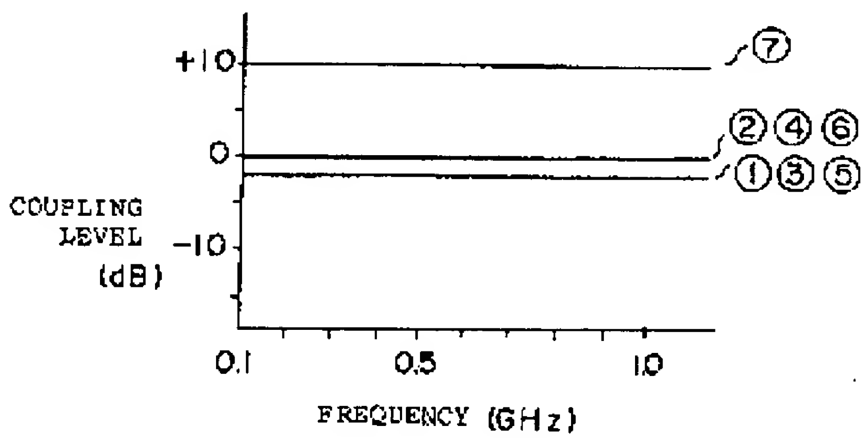
FREQUENCY (GHz)

Fig. 6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1.0
FREQUENCY (GHz)

Fig. 7

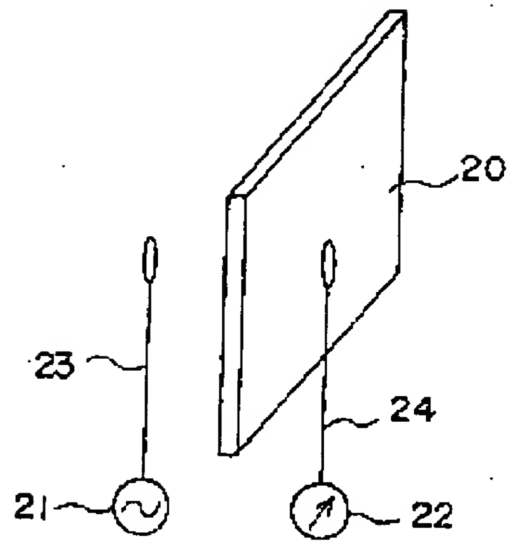

Fig. 8

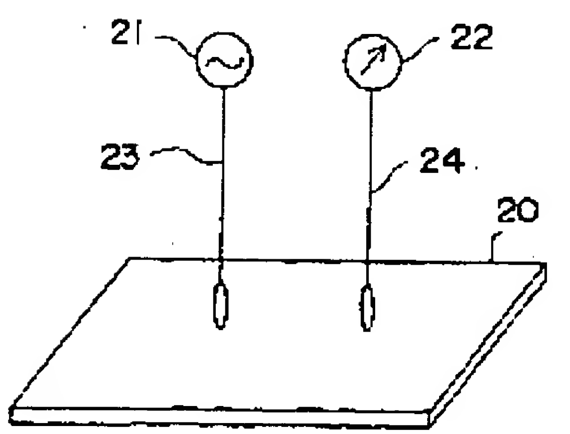

Fig. 9